

The Lacustrine Estuary Might Be a Useful Concept

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Twenty years ago when Charles Herdendorf and others proposed the concept of estuaries associated with the North American Great Lakes, I reacted with predictable incredulity and immediately dismissed it. Several decades later I realize to my great shock that I have actually reached a state of accommodation with this idea. While this may be a sign of early senility on my part, I think that there are enough good reasons to try this concept for a few years and see whether it works. Before we do that, however, I think a broadening of Herdendorf's concept is necessary. It is clear that this type of environment can be associated with many of the larger lakes in the world. For example, Lake Victoria in Africa, Lake Balaton in Hungary, lake Baikal in Eastern Siberia and Lake Okeechobee in Florida all have areas similar to those described for the Great Lakes. To make this a more universal concept I suggest the term "lacustrine estuary" or "lake estuary."

A Gradual Change of Heart

As with most people, my initial rejection of the idea of lake estuaries is associated with their typically low concentrations of dissolved salts. Everybody knows that estuaries are locations where salt water and freshwater mix. However, what we often forget is that the definition of estuary has been modified a number of times over the past half century and, in fact, is based upon the Latin word *aestuarium* which means tide or "heaving of the sea." Notice that salt or salinity is not an inherent part of the original Latin word. My opposition has weakened even further after seeing some of the so-called estuaries around the Great Lakes. They actually look and function like their saltier counterparts. Typically, they are semi-enclosed areas of high sediment deposition, usually have some sort of density or ionic concentration gradient, have expanses of emergent and floating vascular plants, and have an important nursery function for juvenile fishes and invertebrates associated with the

nearby lake. Even more disconcerting is the usual presence of both lunar and wind-driven tides. The structural and functional resemblance to the tidal freshwater end of marine estuaries is most striking.

Somewhat less compelling is the political aspect of this controversy. Many years ago the National Oceanic and Atmospheric Administration (NOAA), in its infinite wisdom and with a heavy political push from Washington, D.C., included the Great Lakes in the Sea Grant Program and actually established an estuarine sanctuary on the shores of Lake Erie at Old Woman Creek. While we can debate the scientific fine points, it is clear that the United States Government has declared that estuaries exist in the Great Lakes.

Concepts are only useful if they help to transmit knowledge and unravel complex scientific problems. With this point in mind, the concept of "lacustrine estuaries" helps differentiate them from marine estuaries in a student's mind while at the same time allowing a whole range of interesting comparative scientific studies. For example, since lacustrine estuaries bear remarkable similarities and some interesting differences from the tidal freshwater portion of marine estuaries, an understanding of nutrient cycling in one environment should help significantly in the other. Knowledge of larval fish utilization of the Hudson River Estuarine Sanctuary (tidal freshwater) should give interesting insight to the situation at Old Woman's Creek Estuarine Sanctuary on Lake Erie. Conversely, scientists working on the invasion of Great Lakes estuaries by the zebra mussel (*Dreissena polymorpha*) could serve as early-warning studies for estuarine ecologists who will probably be forced to confront the zebra mussel in the freshwater end of our marine estuaries very soon.

Given all these reasons, it seems reasonable to experiment with the concept of lake estuaries for a decade or so and see whether it has any real utility. If not, it will simply disappear as a heuristic tool. However, it may prove to be useful enough

to survive and catalyze some very interesting scientific studies and interactions between limnologists and estuarine ecologists.

A Definition

To be sure we are on the right track with this concept and that it has broad utility, I suggest the following working definition. **A lacustrine estuary is characterized by (1) an association with a large lake (i.e., a lake which has a measurable lunar tide), (2) being geomorphologically semi-enclosed, and (3) having upland drainage which mixes within the estuary with lake water.** Inherent in this definition is the idea that mixing may create both horizontal and vertical gradients in dissolved ions or density, but does not define the exact nature of these gradients. For example, during the autumn there may be a density gradient from colder stream water flowing into warmer lake water while in the spring the situation may be reversed. Similarly, gradients of dissolved ions may operate in either direction depending upon whether the receiving waters are similar to Lake Michigan or the great Salt Lake of Utah.

A Final Challenge

If the scientists who work on the Great Lakes really believe that the lake estuary concept is use-

ful, why not join forces with those of us who work on marine estuaries. This could lead to an interesting increase in exchange of ideas and new conceptual approaches to both our sciences. In October of 1989 while at the Great Lakes conference at Old Woman's Creek, I suggested during my presentation that if those scientists who worked on the so-called Great Lakes estuaries were serious about their use of the word "estuary," they should form a special subsection of the most active estuarine scientific group in the United States, the Estuarine Research Federation (ERF). Since we already have five regional societies (NEERS, AER, SERS, GERS, PERS), why not organize a Great Lakes Estuarine Research Society (GLERS)? Further, why not pick an obvious issue of interest to both marine and lacustrine estuarine scientists, and join us at our next biennial meeting in San Francisco. A logical topic would be the zebra mussel (*Dreissena polymorpha*) and its ecological impact on both types of estuaries. Hopefully, this can lead to further interaction and cooperative studies in the future as reflected in papers in *ESTUARIES* and at subsequent ERF meetings.

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